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arch, 1924 The Relation of Science to Modern Education and Civilization.

By Raymond C. Osburn.

When the invitation to present this address was made, it carried with it the suggestion that I might wish to bring to you some message from my own field of work. On first consideration nothing seemed easier, for biology is a broad subject and I was assured of a highly intelligent audience, - an audience, moreover, accustomed to listening, more or less, to what professors have to say. When I came to consider more carefully what line of thought to take up, I found some difficulties in the way.

Some of my audience have specialized in the field of biology, many have had at least the fundamentals, but others have had none of this work in college and a few might even have to look up the meaning of the word in the dictionary. In the attempt to present something that may be understandable to all, I have decided to ~~discuss~~ ^{some of} ~~present~~ briefly, as I see it, the relation^s of science to modern education and to present day civilization.

Civilization is merely a name for any state or condition of human society and the more complex and interwoven the societal relations, the higher we consider the civilization to be. Education

is the means by which the individual is trained fit himself into his particular civilization, to find his place in human affairs and make the most of life.

Now, as civilizations vary in different parts of the world and from time to time in any one region, it necessarily follows that what constitutes education must vary with time and place.

Men have evidently been educated at all times according to the needs of the age, but the successful man of the Old Stone Age had to master many things which we do not need to know and few things of our civilization were required of him. The education of ancient Greece was not at all that of the barbarian, but neither did it involve much that is necessary today. Mark Twain's Connecticut Yankee found himself very much out of place in King Arthur's Court, but it is a safe guess that King Arthur would have been much more at a loss in the Yankee's Connecticut factory and would have found adjustment practically impossible.

On down through the renaissance of learning and until the beginning of our modern period educational change was very slow, and, though different, it was much on the same general level as both in substance and in the manner of presentation, for science

had not yet opened up new fields of thought, nor complicated
~~in the old days of Greece and Rome, for science had not yet~~

~~complicated~~ the affairs of society. The ^{natural philosophy} science of the Middle

Ages was, in fact, only a recrudescence of that of the Greeks,

and the Darwins, the Pasteurs and the Helmholtzes of ~~that~~ those

days ~~periods~~ were struggling toward an understanding of many things

which we teach our children in the grade schools of today.

It is difficult for us to comprehend that only a hundred
years ago, all of physics, chemistry, biology, geology, astronomy

and the other branches of natural science, was taught from one *text*

book of Natural Philosophy, without laboratory work and usually

without demonstrations of any kind.

Science has contributed so largely to our modern civilization,-

and in so short a time that the mind almost whirls in trying to

grasp the speed of the process,- that the man of today who is not

familiar with at least the fundamentals of the various sciences

is out of step with our civilization. His mind may be stored with

all the lore of the past ages, but if he is not in touch with

modern science he is not educated, he is merely learned,- and there

is vast difference.

Humanity has been advancing its body of traditional knowledge for thousands of years and the sum total of this accumulation is stupendous. There is only a limited amount of time at the disposal of each individual for securing an education suited to our complex^x modern civilization. It must be done for the most part during the student period of life, for even the best prepared college graduate will probably have to step very lively to keep up with the procession of advancing civilization during the rest of his life.

The question arises then as to how much of the accumulated traditional knowledge of the past is necessary to the student of today, and our modern educators will measure their worth to humanity by the success with which they eliminate the unessentials of the past, - things which may have ^{been} a necessary part of training at one time, but are no longer.

The tendency is always for education to lag behind civilization somewhat, for educators always belong to the passing generation and they are often slow to fit into the educational scheme anything which may appear to them of merely passing significance.

Our modern education is often accused of catering to ^{transient} ~~passing~~ fads and possibly there is a measure of justice in the criticism, though I believe that in general the opposite condition is true. In view of the fact that the fad of today often becomes the recognized procedure of tomorrow, it seems to me that every new feature of our civilization should be carefully weighed to measure its lasting values, and incorporated into our educational scheme as soon as it appears to be important, even if some worn-out ~~phase~~ must be eliminated to provide a place for it.

What we must aim to do is to carry the student, in his first 21 years or so, through the essential part of this background of knowledge (as much of it as we should know today) so that he may cover, in that short period, what the race has been so long in working out. The recapitulation must be rapid and often sketchy up to the last century of human progress. From then on it will necessarily be increasingly detailed and will involve more and more of science, and it must not stop short of the present. We are living in the Age of Science and Science must be taught.

History acquaints us with the road that civilization has traveled, but the history that is confined to the accounts of the battles of successful conquerors or the exploits of power-grasping politicians is of little importance. The history that is most worth while is that which recounts the development of the arts and sciences and their influence on society and civilization.

The important facts of history are not that Alexander sighed for more worlds to conquer and died a drunkard, that Caesar became master of the known world and was assassinated because he was thought to be ambitious, not that Napoleon overran western Europe and died in exile on a desert island. Rather, the things worth knowing ^{other peoples} ~~they~~ are what ~~were~~ ^{came} to the Greeks, Romans and ~~French~~ ^{of those} have contributed to ~~periods in~~ ^{our} modern civilization.

The greatest names of history are those of the men who have made possible our modern civilization. Flavio Gioia first poised a magnetic needle on a pivot, but the influence of his invention has extended to the present, wherever ships sail the seas or explorers traverse ~~new~~ new lands. It was the

essential feature in the discovery of America and the voyages of DeGama and Magellan, and a whole department of the Carnegie Institution is still engaged in studying the idiosyncrasies of this little magnetized needle balanced on a point. Copernicus gave us a new cosmology. Watt gave us the steam engine and Morse the telegraph, two scientific inventions which have remodeled commerce and international communication. Jenner discovered the principle of vaccination and laid the foundations for the science of preventive medicine. Wells and ^{through the} Morton, ~~the discoverer~~ of anesthesia ~~and its application to~~ and surgery ~~and~~ dentistry, have saved suffering humanity ^{every} yearly more pain than was caused by all the wars of Napoleon.

Such things as these are the most worth knowing, since they have left an indelible impress upon our modern civilization, ^{which} and time will not eradicate it. They were the results of science and they have contributed lasting benefits to our present society, with many elaborations by later scientists. They should be made more a part of our educational background, since knowledge of them is necessary to the interpretation of our present civilization. *"The time has come for a crusade which will plant the flag of scientific truth in a bold position in every province of the modern world" (Gregory, "Science", Nov. 11, 1921, p. 449)*

I would not have you think for a moment that I consider science the sum total of education, for I am assured that the languages, literature, philosophy, etc., are so much worth while that many students should devote the major part of their time to them and that all of us should know something of them, for they also are a necessary part of education. Even if they serve no other purpose they are requisite to a proper breadth of view or as tools of trade.

What I do mean to emphasize is this, that no one at the present time can afford to devote himself entirely to the so-called humanities to the exclusion of modern science, for to do so leaves him out of contact with the world and its progress.

For, science is the largest item in our modern civilization and is, in fact, what distinguishes it from the past. One of the most astonishing things about science is the fact that its growth and its applications are so modern. The past century and a half have seen the development of nearly all of it. This is partially understandable when we consider the lack of

applied science before that time. When chemists were merely searching for an elixir of life or studying the nature of simple chemical combinations, it is little wonder that they did not attract much attention. As long as the physicist was merely experimenting with the nature of solids, fluids and gases, he was not likely to be considered highly by the general public. When the biologist was merely making collections or squinting through a microscope at unknown forms of life, he could scarcely expect to be thought more valuable than a harmless crank.

It was when the applicability of these studies to human affairs became apparent that science came into its own. When the chemist and biologist proved their ability to remodel medicine and to cope with disease, they began to be looked upon with favor. When the physicist showed the relation of his science to engineering, he came into good standing. When the humble bug-catcher showed that he could control the

ravages of insect pests, the laugh was on the other side. When the agricultural scientist proved his ability to "make two blades of grass grow where one grew before", the world took off ~~his~~ its hat to him.

There are scientists who claim to be interested only in the facts and principles ^{of their subject} and who profess to scorn its applications. This is all very well for them, if they are unable to see the applications, as is probably the case, and it does no particular harm, for if their work have any human value some one else more practically minded will soon make the application for them. Whatever may be one's personal feeling as to research in pure as against applied science, the latter is the only phase that touches civilization vitally. Every discovery of science that is of value to humanity will sooner or later find its application. This has been the history of countless results of work in the field of pure science, ^{and one can never forecast the results of research.} The principles of ionization and radio-activity have found an important place in applied science in a quarter of a century. The discovery of the important functions of the ductless glands brought about the development of the field of endocrinology with unsuspected applications in ~~the~~ medicine.

I do not know that science has made man any happier or more contented in modern times than he was in the Middle Ages, but it certainly has given him many more comforts, has lifted great masses of people out of drudgery, has eliminated much of disease, famine and pestilence, and altogether has made the world a brighter and better place in which to live. It may not have lengthened the natural span of life, but it has made it possible for a much larger percentage of mankind to live out ^{that} span. It has opened up supposedly uninhabitable regions of the world to productiveness, commerce and habitation and it has enabled the population of the world to be greatly increased, - if there be ^{any} merit in this mere fact. It has given us modern surgery and medicine, has made possible all of our modern inventions and all of our great engineering projects. It has changed our whole attitude toward the world in which we live and has affected even religion by stripping from it many of the traditional superstitions by which it has always been fettered.

So high a place has science taken recently in human thought that many ~~other~~ subjects, formerly content to be quite independent, are now claiming kinship. The study of politics has become political

science; the mental philosophy of the past is now the science of psychology; students of language claim a science of linguistics, and modern historians look down upon their less advanced brethren as unscientific. A recent bulletin from the University of Iowa makes the statement, "A science of education is appearing highly organized and based upon incontrovertible facts, the issue of patient investigation". (Bull. Univ. of Iowa, n.s., No. 271, p. 3). Some philosophers are redefining their field as the science of the sciences. Even one religious cult has adopted the magic name of science, though the application here is a little difficult to grasp.

The fact that science is taking ever a larger and larger place in human thought and human affairs has been the source of an undue amount of worry among the more conservative element of our present civilization, who see many of their pet traditions roughly displaced, and such persons have not hesitated to voice their fear and displeasure over the fact that "the old order changeth".

While the advancement ^{of science} has contributed enormously to the welfare of humanity, as evidenced by some of the changes in our civilization and while it will probably yield vastly greater already enumerated, ~~and has further possibilities of the~~ benefits in the future, ~~greater good~~ it does not necessarily make for human happiness

and there may be in it some possibilities of evil. However, it is probably the scientist himself who is in the best position to judge of the value or of the peril that may lie in the advancement of organized knowledge.

The most distinct element of danger lies in the chance that our scientific knowledge may too far outrun our social organization and our moral understanding. This should not happen, however, if our social, moral and religious teaching is made to keep step with the advance of knowledge in scientific lines. There are powerful and influential obstructionists actively at work in the social, moral and religious fields, who are apparently incapable of realizing that an advancing civilization requires progress along these lines. Such men as these, and not the scientists, will be responsible if civilization becomes overbalanced on the side of science.

We ~~have~~ made great progress in our social organization in Europe and America, especially, in the last century and a half, but science has made vastly more. It has made possible rapid transit over the whole world and through long distance communication, we in America, for example, may know what has occurred in Europe several hours before the event took place! The effect of these has been

to place the nations of the world in close touch with each other, physically, and even to greatly widen our social relations with other peoples. But the world has not yet awakened to its increased moral responsibilities, - responsibilities that are greatly changed now that all nations of the world are neighbors. Science knows no boundary lines, color differences, nor even language separation.

Yet there are ^{distinct} differences in American, French, German and Japanese social organization and, apparently, even greater differences in the conceptions which these nations have of their moral obligations to the rest of the world.

It is chiefly to the credit of ~~of~~ science that such understanding as now exists among the nations of the world has been fostered, and science, more than anything else, will eventually break down international boundaries and place the whole world on a unified basis. Easy and rapid communication ~~have~~ have brought Europe and America closer together physically than Connecticut and Massachusetts were in the days of the Revolution; closer than the North and the South were before the Civil War, and this close contact cannot result otherwise than in a final removal of international misunderstanding and prejudice.

The conquest of the world was the dream of the great militarists of the past and there is more than a suspicion that we would not have to go back more than about ten years to encounter it, but no vision of a Hague Tribunal, a World Court, or a League of Nations for the common good of all, - a brotherhood of states in which all peoples should have a part in the settlement of their common misunderstandings, - has been thought feasible until recently. Despite the fact that there are still many, even in the most enlightened nations, who consider a world federation impracticable, it is nevertheless the condition toward which our civilization is trending, - toward which the very unescapable contact of every nation with every other nation is inevitable driving us and, ^{it} is the only plan under which we can live in peace and common understanding. Science more than all other factors is forcing upon the world this changed viewpoint, by facilitating contact and by breaking down racial, social and political prejudice.

With the advancement of biological science we have learned more about the conditions of human life and human behavior and have done more to alleviate the severest conditions of human life in the past century than in all the ages preceding. Most of what we have learned has come through the study of lower organisms and, for the beginning student, the chief merit of general biology is in the light which is thrown upon the human organism by considering the lower forms of life.

The student who fails to see himself reflected in the processes, structures and reactions of the lower forms which are offered as a sacrifice on the altar of knowledge, misses the whole point to biological study.

Through anatomy, histology, embryology, physiology and biochemistry we have learned that man is merely one of a series of ~~forms~~ organic beings, with the same sort of fundamental processes and responding in the same way to similar conditions of environment. Through paleontology we have learned that he has been a long time evolving into his present condition and we know much about the path he has trod in reaching his high estate. By comparative psychology we trace the development of his mental processes. Sociology has opened up to us the nature and evolution of his group reactions. The results of anthropological and ethnological studies enable us to compare the different races of men and to form some judgment of their educability and the possibilities of their higher socialization. Bacteriology, parasitology and pathology have enabled us to learn much of the nature of human disease and the methods by which much of this may be avoided or cured. Surgery and dentistry have also enabled us to eliminate much of human misery. Botany has shown us the methods of

increasing food production, as well as the possible limitations to this. Genetics has explained away the mysteries which have always surrounded the transmission of hereditary characters in man and other organisms, has shown how and in what proportion many undesirable human traits are perpetuated and has indicated how man can assume control of his own heredity to the improvement of his racial stock.

Two of the greatest problems that will confront mankind in the near future are, first, the food problem and, second, the elimination of the unfit among us. There is no use in being squeamish or over-sentimental about these matters, for they are problems that must be faced and, like Banquo's ghost they "will not down."

The population of the civilized world has increased several times over since the Middle Ages and it is a safe estimate that within a couple of centuries, at the present rate of reproduction, the world will have as large a human population as the food supply will support. All of western Europe is now over populated, to the extent that twenty-five to fifty percent. of the food supply must be imported, and ^{some} other regions of the world have long ago reached the famine ^{stage.} ~~limit.~~ Improved agriculture can only postpone temporarily this eventuality for the production of food is definitely conditioned ^{upon} by certain well

known factors.

Science has been responsible for this increase in population, for, with the advancement of knowledge, man has gradually removed many of the former checks to increasing population and especially those bearing upon the physically, mentally and socially unfit. In other words, in our modern civilization, the principle of the survival of the fittest no longer applies to man. We have removed, to a large extent, the ^{and famine} barriers of disease, which in former centuries eliminated especially the physically weak, the mentally incompetent and the socially degenerate, and we have made it possible not only for them to exist and become a constant drain upon our resources, but we have permitted them to reproduce without let or hindrance, so that their number is proportionately rapidly increasing. Since we care for them and their offspring, they are placed in a favored position and have become the internal parasites of our social system.

This is a problem which the advancement of human biology ~~has~~ and a sympathetic understanding of the nature of these unfortunates ^{has been made} has imposed upon the race, but, though it ~~is~~ possible for the unfit ~~to live~~ among us to live in a measure of comfort and security and to become a menace to civilization by the increase of their numbers,

biological science has also ~~xxx~~ shown us the cure for this condition.

The answer lies in artificial sterility, which must be imposed upon *the* members of the human race, genetically unfortunate ~~excessive~~, that they shall not overwhelm us.

We are living in the golden age at present, with the easiest conditions of life which the world has ever known, thanks to scientific discoveries, which have removed the barriers of disease, opened up new fields of food production and greatly increased the output of old fields, and through commerce, by which food distribution may be equalized. At ~~the~~ the present rate of increase in population the food problem will become ~~increasingly~~ a serious one within a very few generations. It is already time, therefore, that thinking people should carefully consider means for ~~protecting~~ ^{relieving} the better portion of humanity from the burden which a humane condition of society has imposed upon itself, that of the care of its hereditarily imbecile, criminal and socially degenerate classes. It must be done thoroughly ^{and} it can ~~be~~ be done humanely. For the welfare of humanity, the unfit among us, while given ^{personal} solicitous ^{personal} care, must not be permitted to "bring forth after their kind", or the burden will be greater than can be borne.

While on this topic of biology in relation to human welfare I cannot resist the opportunity afforded to call your attention to an insidious menace to progress along this line. I refer to the agitation which arises frequently to prevent experimentation on the lower animals. Practically all that man has learned about his own diseases and those of the lower animals as well, has come as the result of such experimentation, yet the misplaced sentimentalism of a portion of our own race would enact laws to make such work impossible. We owe our advances in surgery and our knowledge of serum therapy, inoculation, ~~and~~ the internal secretions and the infectious diseases largely to these experiments. This work has already been of inestimable value to mankind, but while a single disease remains unconquered the search for knowledge of its control must continue. It will be to our everlasting shame if we permit anyone to block the wheels of progress in a matter so ^{important} ~~valuable~~ to all of us as the elimination of disease.

^{It is}
~~I~~ have said that this is the age of scientific achievement, but thus far our science has been devoted too largely to the exploitation of natural resources. We have wastefully misused our heritage and the future will suffer for it. We should already have

devoted much greater effort to conservation, for our forests are being depleted, our streams polluted, our wild life disappearing, our coal, gas, oil and other mineral wealth being wastefully used. But, more than all, the conservation of the highest portion of the human race is the greatest problem that confronts us and, unless proper steps are taken by the educated portion of humanity, our civilization will again sink into the mire of mediocrity from which it sprung, just as other civilizations before us have done.

Modern civilization has at hand the tools with which it can either dig its own grave, or by the proper use of ~~which~~ which it can raise itself into a social efficiency greater than the world has ever known.

Knowing these things, to what use shall we put our knowledge and who will see to it that it is applied? The message is being given to thousands of educated, college trained young men and women of today, who will be remiss in their duties to humanity unless they seriously consider the problems which confront the race.

Not everyone can contribute to the direct solution of these problems, for the answer lies in scientific research and it seems evident that comparatively few are mentally adapted to investigation in the field of science. But everyone with average common sense can master the fundamental principles, can know the methods by which scientific men arrive at their conclusions and can appreciate, at least in part, the meaning of science ~~in relation to~~ our civilization. and the part which it has played in ^{the} ~~its~~ development of These things all students, all intelligent people have a right to know, but I fear that it is often the case that students pass their courses in chemistry, physics or biology, without ever having their attention called to the great importance of these subjects in human affairs. If so the fault lies with the teachers and ^{not with} the educational system and it should be easily corrected.

In closing I desire to state my firm conviction that fundamental ~~and~~ in the broader aspects of biological science especially, education in science, to the end that we may have an appreciation of the world and its contents, of man's place in nature and in society, of the limitations of food production, of public health and social sanitation, etc., is not only the most important and practical feature

of modern education, but that the results of science must be considered, accepted and applied if our civilization is to survive. Man has already determined many of the things necessary to his physical betterment and I have faith that he will be able to discover and apply what is necessary for his moral and social progress. In view of what mankind has accomplished in the past few centuries, we have no occasion to be pessimistic about the future of our civilization.